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OLDER DRIFTS IN THE ST. CROIX REGION¹

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Some of the glacial features of the St. Croix-Dalles quadrangle were described in a previous number of this *Journal*.² That paper was based upon field studies during the summer of 1904. Up to that time no certain evidence of any drift-sheet older than the Wisconsin stage of glaciation had been recognized, and in consequence that paper confined itself to a discussion of the two drifts of Wisconsin age which occur as surface formations within the quadrangle. But with the aid of a class of students from the University of Chicago, during the field season of 1905, the presence of a considerable amount of drift distinctly older than the Wisconsin red drift was clearly recognized at a number of points along the St. Croix River. Two years later a study of the deep ravines which dissect the river bluffs opposite Osceola, Wis., resulted in finding that there are two very distinct drift-sheets in this region belonging to earlier glacial epochs. The earlier of these is a sheet of grayish-black drift brought in from the northwest by a Keewatin glacier. At some later date a sheet of pinkish-red or reddish-brown drift was spread over the region by a glacier from the Labrador center coming by way of Lake Superior.

THE GRAYISH-BLACK DRIFT

The deep ravines opposite Osceola which head back from the river to the Minnesota uplands afford the best opportunities to study the buried Pleistocene deposits of the region. At the bottom of the big ravine in the south part of Section 16, Franconia (about 100 yards east of the wagon road), is a gully-bank exposing ten feet of very dark grayish to bluish-black till. This dark drift is highly calcareous and contains relatively few pebbles and these mostly small. It is largely a rock flour derived by glacial grinding from limestone and

¹ Published by permission of the Director of the U.S. Geological Survey.

² R. T. Chamberlin, "The Glacial Features of the St. Croix-Dalles Region," *Jour. of Geol.*, XIII (1905), 238-56.

shale formations. The most common pebbles found in it are limestones, granites, and greenstones. In its upper portion it gradually becomes brown, passing into yellow-buff above. These brown and buff portions are obviously merely the partially oxidized phases of the drift which was originally nearly black in color. Upward the till becomes less and less calcareous, due to leaching. The great amount of calcareous and argillaceous material as well as the distinctive assemblage of crystalline pebbles in this drift indicates that the ice which deposited it came from the northwest and traversed the extensive limestone and shale areas of Manitoba. It is an unmistakable Keewatin drift.

So far as could be determined, it appeared to be identical with that great mass of bluish-black drift which makes up the bulk of the strong moraine ridge through which the Northwestern Railroad has cut its way, half a mile east of Hersey, Wis. This smooth ridge of thickened drift near Hersey marks an eastern border of a great Keewatin ice-sheet. Hersey is thirty-five miles southeast of the St. Croix River at Osceola, and hence Osceola should be almost in the line traveled by the Keewatin glacier which dumped Manitoban material near Hersey. The age of this grayish-black drift has not yet been conclusively established, but from what is known about it at the present time and the relations elsewhere in Wisconsin, Minnesota, and Iowa, it would seem best to assign it tentatively to the Kansan. Whether a pre-Kansan drift of similar Keewatin character and blackish color underlies it, as it does in some parts of Minnesota and Iowa, cannot yet be told.

The partially oxidized upper portion of this drift-sheet has been recognized in various portions of the St. Croix-Dalles quadrangle. The wagon road which leads from the Osceola bridge to the Minnesota upland country exposes in descending order the following section of older drift near the top of the river bank:

	Feet
1. Wash material including much from the Wisconsin drift . . .	4
2. Gray-brown to yellow-brown calcareous till which breaks up into hard chunks.	11
3. Stratified sand, light-colored above and rusty-brown below	3½
4. Dark-gray or bluish-gray till which is non-calcareous, apparently having been leached.	2
5. Jordan sandstone.	

Above this section is a long slope with a rise of 35 feet to the highest river terrace. This old drift may therefore once have been fairly thickly covered with Wisconsin drift, since removed by the river.

One hundred pebbles averaging an inch in diameter were dug from the brown calcareous till (No. 2), and classified with the following result:

Fine-grained greenstones.....	29
Limestone.....	21
Granite (10 pink, 8 gray).....	18
Gabbro-diorite.....	6
Quartz.....	4
Greenstone schist.....	3
Quartzite.....	3
Quartzose.....	3
Brown sandstone.....	3
Syenite.....	2
Mica schist.....	2
Red Lake Superior sandstone.....	2
Chert.....	2
Monzonite.....	1
Red porphyry.....	1
	<hr/> 100

The greenstones were largely of the dark Keewatin types. There seemed to be very little even among the gabbro-diorite group to suggest the Keweenawan lavas of the Lake Superior Basin. The glacier which deposited this drift received but little material from Lake Superior or from earlier Labradorian drifts.

Three miles east of Dresser Junction (T. 33 N., R. 18 W., Sec. 11, S.W. corner) the wagon road descending into a deep valley exposes a buff clayey till streaked through and through with silver-gray and bluish-gray portions like the typical banks of Kansan drift in Iowa. The calcareous material has been leached out of this oxidized portion of the till. The unaltered black drift was not seen. Fifty pebbles from this till were classified as follows:

		Percentage
Granite.....	12	24
Quartz.....	10	20
Fine-grained greenstones.....	8	16
Chert.....	5	10
Feldspar crystals.....	5	10
Syenite.....	3	6
Gabbro-diorite.....	3	6
Quartzite.....	2	4
Clay ironstone.....	1	2
Decayed igneous.....	1	2
	<hr/> 50	<hr/> 100

Pebbles in this exposure of the drift were small and scarce. They were mostly soft, showing evidence of much weathering and age. The classification of the pebbles collected shows the unmistakable Keewatin character of the drift even in the absence of limestone. The abundance of chert suggests the former presence of the calcareous element. This occurrence of western drift is three miles east of the limiting terminal moraine of the Keewatin glacier of the Wisconsin epoch, showing that this earlier Keewatin ice-advance was more powerful than the last.

The upper oxidized portion of this old Keewatin drift has now been recognized in limited sections in various other portions of the quadrangle. It has been brought to light in constructing the new railway spur from St. Croix Falls station down to the electric-power dam, and evidences of it have been seen on the Taylor's Falls side of the river. These occurrences suggest that if the entire region had not been buried beneath such heavy deposits of Wisconsin drift this supposed Kansan drift would be found to constitute an important sheet.

THE LOWER RED DRIFT

In the gully in which the true grayish-black till was first detected no pre-Wisconsin red drift was exposed to view, but in the next ravine to the north there was visible an intensely red, firmly consolidated till, or hardpan, upon which rested a rather ferruginous sand, and above that the fresher-appearing sand and gravel of Wisconsin age. A much better section is afforded by the wide, open ravine in the N.W. $\frac{1}{4}$, Section 15, Franconia ($1\frac{1}{2}$ miles southeast of Franconia). Near the head of this ravine the gray Keewatin drift of Wisconsin age is seen resting upon the red Wisconsin sands and gravels from Lake Superior and Labrador. Lower down toward the river is a bank of reddish-brown to pinkish-red sandy till which is bright carmine red at the top. Though a true red drift, it contains many limestone pebbles in some places and locally boils up briskly with acid. The Wisconsin red drift of this region is indifferent to acid and it is very seldom that a fragment of limestone is found within it. A sharply defined contact separates the hard red calcareous till from the overlying unconsolidated sands which undoubtedly belong to the Wisconsin red drift. At the top of the underlying red

till which becomes somewhat clayey at its upper surface, the writer found in 1907 small lumps of decayed vegetable matter and the remains of several tiny twigs. These were all in the uppermost inch of the red till. While there was no continuous layer of humus, these lumps and fragments of former branches were a decided feature of the contact. As this sort of material was found nowhere else in the red till or the sand above, it would seem to mark a true interglacial horizon. From the descriptions it appears to correspond closely with the humus horizon reported by Dr. Atwood and his class in 1904,¹ but which the writer has repeatedly sought but never been able to find, a fact due no doubt to later concealment.

Fifty pebbles from a calcareous portion of the lower red till were classified as follows:

		Percentage
Limestone.....	14	28
Fine-grained greenstones.....	9	18
Red Lake Superior sandstone.....	9	18
Granite (1 pink, 3 gray).....	4	8
Red aphanitic.....	3	6
Jasper.....	2	4
Quartz.....	2	4
Chert.....	2	4
Quartzite.....	2	4
Red quartz porphyry.....	1	2
Gabbro-diorite.....	1	2
Mica schist.....	1	2
	50	100

The red rocks and the character of the greenstones show that this is clearly a Lake Superior drift, but the presence of so much limestone is surprising. Perhaps the ledges which furnished the limestone were covered by drift at the time of the Wisconsin ice-advance, so that the glacier failed to gather up much of this material. There does not seem to be very much black drift below the red at this point, since the rock appears quickly as one goes down the ravine.

Several of the cuts along the Northern Pacific Railroad, between Taylor's Falls and Franconia, show glacial deposits older than the Wisconsin red drift. A cut in the middle of the east line, Section 35, Shafer, exposes a rusty-looking gravelly deposit resting upon the Franconia sandstone. Though much obscured by talus, this deposit was seen to have a thickness of at least twenty feet. The upper part

¹ See *Jour. of Geol.*, XIII, 248.

of the cut is a bank of red Wisconsin drift. Fifty pebbles from this gravelly deposit under the Wisconsin drift, taken from a point six feet above the Franconia sandstone, were classified as follows:

		Percentage
Fine-grained greenstones.....	14	28
Red Lake Superior sandstone.....	7	14
Red quartz porphyry.....	4	8
Jasper.....	4	8
Brown sandstone.....	4	8
Granite.....	4	8
Gabbro-diorite.....	3	6
Quartz.....	3	6
Red diorite.....	2	4
Red aphanitic.....	2	4
Quartzite.....	2	4
Decayed igneous.....	1	2
	50	100

This is clearly a Lake Superior drift brought in by an ice-advance from the Labrador gathering-ground.

This lower red-brown drift is older than the Wisconsin red drift and younger than the grayish-black drift of supposed Kansan age. The nature of its occurrence within the St. Croix-Dalles quadrangle does not afford any very tangible clue to the age of this deposit. But it appears to be almost identical in lithological characteristics, degree of induration, and various minor peculiarities with the sheet of pre-Wisconsin red drift which forms the prominent moraine near the village of Hampton in central Dodge County, Minn. This is fifty miles S.S.W. of Osceola. In this moraine the hummocks still persist, though they have been much sharpened by slope-wash and are now peaked or conical in shape. From the amount of erosion and general appearance of this drift it seems perhaps best to assign it for the present to the Illinoian glacier from the Labrador center.

Similar pre-Wisconsin red drift overlies the grayish-black till in many cuts along the line of the Northwestern Railroad between Hersey and Baldwin, Wis. Some of these exposures show that a considerable interval of time elapsed between the retreat of the ice-sheet which deposited the grayish-black drift and the advance of the glacier which brought the red drift. The buff-weathered phase is present above the unaltered grayish-black till, and in some places this yellow oxidized till has been leached down five or six feet below

the contact with the overlying red till. Some cuts show a distinct erosion unconformity between the two drift-sheets.

At the present state of knowledge, the following drift-sheets have been recognized in the St. Croix-Dalles region:

1. A thin surface mantle of gray Wisconsin drift deposited by a glacier from the Keewatin center, as described in previous papers.
2. An upper red drift deposited by a glacier of Wisconsin age from Labrador, as similarly described.
3. A sheet of brownish-red to carmine-red sandy drift left by an ice-invasion coming from the Labrador center across the Lake Superior basin and extending as far to the south as the moraine at Hampton, Minn.; age consistent with Illinoian.
4. A sheet of dark grayish-black, calcareous, clayey till deposited by a vigorous advance of ice from the Keewatin gathering-ground and extending as far to the southeast as Hersey, Wis.; age probably Kansan, but still open to question.